

SAN FRANCISCO ESTUARY PROJECT

Aquatic Organisms and Wildlife

The San Francisco Estuary sustains thousands of species of fish, invertebrates, birds, mammals, insects, amphibians, plants and other life. However, human use and development in the Estuary have led to degradation of its natural habitats and major declines in many populations. The San Francisco Estuary Project is working cooperatively with diverse organizations and agencies to protect these invaluable resources, restore habitats and promote environmentally sound management of the Bay and Delta.

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The Estuary

San Francisco Bay and the Delta combine to form the West Coast's largest estuary. The Estuary conveys the waters of the Sacramento and San Joaquin rivers to the Pacific Ocean. It encompasses roughly 1,600 square miles, drains over 40 percent of the state (60,000 square miles), contains about 5 million acre-feet at mean tide, and redistributes 80-280 million cubic yards of sediment every year. The Delta and Estuary watershed provides drinking water to 22 million Californians and irrigates 4.5 million acres of farmland. Estuary waters also enable the nation's fourth largest metropolitan region to pursue many activities including shipping, fishing, recreation and commerce.

Life In and Around the Estuary

Apart from the nine million human residents around its shores, the Estuary and its watershed sustain diverse aquatic organisms and wildlife. About two thirds of the state's salmon pass through the Bay and Delta, as well as nearly half of the waterfowl and shorebirds migrating along the Pacific Flyway. The overlap between marine, freshwater and terrestrial ecosystems in the Estuary region creates a rich mixture of habitats and species. Many species exist in viable, interdependent food webs despite the presence of big cities, farms and industry. Many others are in long-term decline, succumbing to urban growth, pollution, water development, disease, predation, loss of habitat and other factors. Those who manage the Estuary region are now working to maintain an environment in which both humans and wildlife can flourish.

History

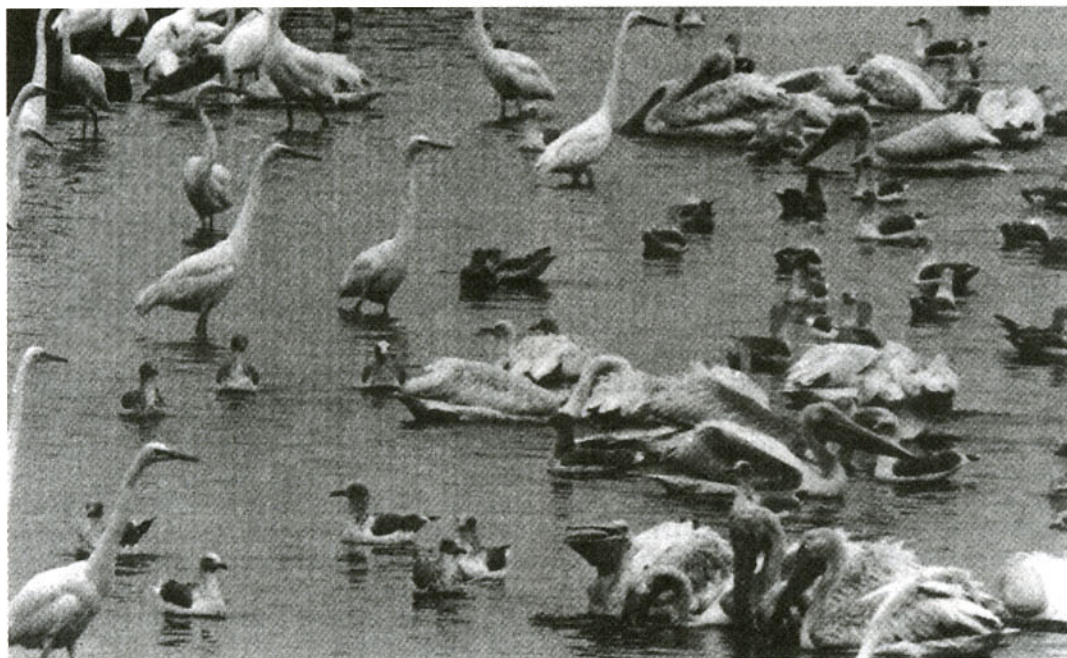
A few hundred years ago observers reported that migrating birds blackened the sky over the Estuary. One visitor reported salmon runs so dense that Delta rivers looked like a silver "pavement."

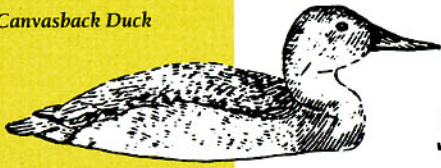
Commercial hunting began in the late 1700s when trappers slaughtered thousands of otters in the Estuary. By Gold Rush times hunters were delivering millions of waterbirds and shorebirds (and their eggs) to the tables of a growing populace and egret plumes to hat makers. Commercial fisheries were soon harvesting millions of pounds of Dungeness crab, grass shrimp and salmon, and decimating delicacies such as the sooty crayfish and red-legged frog.

Eventually, excessive hunting, fishing, pollution and other human disturbance brought about dramatic declines of many furbearing and game mammals, migratory waterfowl and other birds. Expanding agriculture and urban development soon enveloped most wildlife habitats. Oak woodlands fell to the axe, lush riparian habitats gave way to bare levees, marshes disappeared under salt ponds and farm crops, and waterways were channelized to make way for upstream shipping.

In the last half-century other threats to wildlife emerged. Pesticides threatened bald eagles, pelicans, ospreys and peregrine falcons. Massive withdrawals of ground and surface water for agriculture, cities and industry altered local ecosystems.

Today, little space and few natural resources remain on Estuary shorelines to sustain the region's once abundant plant and animal populations. In the water, fish and other organisms face increasing threats of habitat alteration, disturbance and contamination.





Status & Trends

Current Factors Affecting Wildlife and Aquatic Organisms

Habitat Loss and Fragmentation:

During the last 140 years, the Estuary's native wildlife habitats have been drastically reduced to islands in a sea of cities, suburbs and farms. Habitat loss and degradation forces wildlife to concentrate in small, isolated areas, often increasing vulnerability to other threats.

Hunting: Hunting is the largest single mortality factor affecting waterfowl. A total of 998,328 ducks were killed in California in 2000. To provide habitat and encourage population recovery, hunting is now carefully managed through regulations on limits, seasons and methods of take. Other hunted species include dove, pheasant, quail, rabbit and deer.

Fishing: Commercial overexploitation of certain species such as chinook salmon and white sturgeon contributed to their declines in the early part of this century. Today, the Estuary still supports stable anchovy, herring and shrimp bait fisheries.

Disease: Diseases such as avian cholera and botulism kill thousands of waterfowl wintering in the Estuary. Water management practices and sewage effluent discharges often cause or exacerbate waterborne disease problems. Susceptibility to disease increases when birds concentrate in small remaining habitats.

Predation: While predation usually provides important natural limits on prey species, many birds and animals live in such suboptimal conditions that they become dangerously vulnerable prey. Predators of particular concern today are the growing numbers of non-native red foxes, rats, opossums and feral cats that raid bird nests.

Contaminants: Environmental contaminants present in the Estuary in potentially harmful concentrations include trace elements such as cadmium, copper, mercury, selenium and silver, and chlorinated hydrocarbons including pesti-

Primary Producers: Microscopic algae (single-celled plants) form the foundation of the aquatic food web. These primary producers, known as phytoplankton, grow and drift in the water, to be eaten by zooplankton (floating and drifting animals), which are in turn consumed by juvenile fish and shrimp.

Trends: Phytoplankton biomass within the Estuary varies dramatically, both seasonally and by location. Phytoplankton production rates in San Francisco Bay are similar to those observed in the ocean, but are lower than those in most estuaries. Phytoplankton biomass has declined significantly in the North Bay due to intensive filtering by the introduced Asian clam (*Potamocorbula amurensis*). *Potamocorbula* filter-feeding has not depleted the South Bay phytoplankton bloom, unlike in the North Bay.

Zooplankton: These plankton include water fleas, opossum shrimp, copepods, rotifers and other microscopic animals and are found throughout the water column. They are important food sources for small or larval fish.

Trends: With the exception of copepods, the abundance of all types of zooplankton in Suisun Bay and the Delta has decreased in recent years. Copepod abundance has increased due to the successful introduction of several species.

Benthic Organisms: The benthos is the zone at the bottom of the Estuary inhabited by mussels, clams, crabs, shrimp and other aquatic organisms. Many burrow in the mud and filter water and sediments for food.

Trends: Clam populations fluctuate, largely in response to predation and harvest, pollution, seasonal cycles and invasions of new species. Since 1998, juvenile Dungeness crab abundance has been near or at record high levels, most likely due to favorable ocean temperatures and a relatively weak northward current. The mushrooming *Potamocorbula* population has led to changes in other benthic species, possibly due to the clams' "overgrazing" of the system. The grass shrimp (*Crangon franciscorum*) continues to decline because of inadequate freshwater inflows and other factors.

Fish: More than 120 species of fish depend on the Estuary for all or part of their lifecycles. Resident species, such as splittail, topsmelt, dwarf perch and many types of gobies, generally live in the Estuary throughout their lives. Seasonal species reside both in the Estuary and in other areas, like the Pacific Ocean. These species typically use the Estuary as a nursery area, but some use it as an extension of their usual habitat. Seasonal species include Pacific herring, jacksmelt, starry flounder, white croaker, northern anchovy and prickly sculpin. Anadromous fish live some or all of their adult lives in saltwater but migrate to freshwater

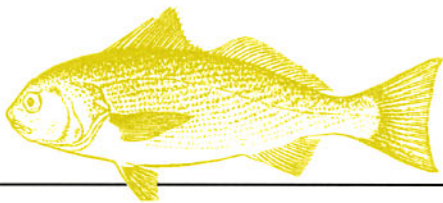
to spawn. Four runs of chinook salmon migrate through the Bay and Delta each year. Other anadromous species include striped bass, delta smelt, longfin smelt, American shad, white sturgeon and steelhead trout. Striped bass, though a non-native, is used as an important indicator species for the study of estuarine environmental conditions.

Trends: Splittail (listed as threatened under the federal Endangered Species Act) have exhibited moderate overall abundance since the late 1990s. Catches of the chameleon goby and the shimofuri goby (both introduced species) have remained relatively stable over the past five years. The invading shokihaze goby is on the increase. Since the 1997-1998 El Niño, the spawning biomass of Pacific herring has remained below the long-term (since 1978) average. Starry flounder have declined, and white croaker abundance, up in the early 1990s, has been low for the past five years. For northern anchovy, the 2001 abundance index was the second lowest since 1980, but with the return of cold ocean water, anchovy abundance may increase. Natural spawning chinook salmon are in decline, largely due to dams and diversion. Most populations of Central Valley chinook salmon are relatively stable, but winter-run chinook have been listed as both a state and federal endangered species since 1994. Spring-run chinook also are listed as both a state and federal threatened species. Striped bass have suffered record low populations. Adult abundance now appears to be increasing, while juvenile abundance is not, making predictions difficult. Abundance of the delta smelt, listed as a state and federal threatened species in 1993, generally increased throughout most of the 1990s. There have been long-term declines in longfin smelt. White sturgeon declined through much of the 1900s, but have generally increased in recent years.

Songbirds: Dozens of species of songbirds live around and migrate through the Estuary, including warblers, sparrows, larks and thrushes. Their habitats range from oak savannah and grassland to riparian forests, where trees, cattails and other vegetation along waterways make excellent nesting sites.

Trends: Some species, such as the salt-marsh-dwelling Alameda song sparrow (California Species of Special Concern), have declined due to loss of habitat and introduced predators and competitors.

Shorebirds: Over a million shorebirds use the Estuary each year. In addition to providing year-round habitat to such non-migratory species as the black-necked stilt and the American avocet, the Estuary is an important wintering stopover for migratory shorebirds, such as western sandpipers and plovers. Indeed, the Estuary attracts more migrating shorebirds than any other wetland area in California. At least 34 species live, nest and forage for food on the tidal flats and salt ponds along the Estuary's shore.



White Croaker

Trends: The long-billed curlew is declining due to habitat loss and drought. The black-necked stilt, American avocet and Wilson's phalarope appear to have been increasing in response to conversion of tidal marsh to salt ponds suitable for nesting, feeding and raising young. Many shorebird populations, including the endangered clapper rail and black rail, are suffering from introduced species, such as the red fox (a predator) and salt marsh cordgrass, which reduces the suitability of foraging area.

Waterfowl: The Estuary supports over 30 species of waterfowl, including dabbling and diving ducks, which feed in shallow and deeper open water respectively, and swans and geese, which forage in wetlands and fields. The Bay provides a major coastal wintering and migratory staging area for a variety of Pacific Flyway ducks. Suisun Marsh and the Delta attract both dabbling and diving ducks, as well as geese, swans and cranes.

Trends: Total waterfowl numbers in the Estuary dropped from a record high of 1.3 million in 1977 to a low of 109,000 in 1982. By 1992, total midwinter counts had rebounded to roughly one million. But in a winter 1999-2000 survey, the U.S. Fish and Wildlife Service found lower than normal populations. Population declines were due to drought, predation and habitat loss—both in the Estuary and its watershed and in Canadian and Arctic nesting grounds.

Colonial Waterbirds and Seabirds: Gulls, terns, herons, egrets, ibises and cormorants feed in the open waters of the Bay and ocean and nest in colonies on isolated islands or salt pond levees. Because they primarily eat fish and other aquatic organisms, these birds are sensitive to contaminant biomagnification in the food web.

Trends: Populations of the double-crested cormorant, California gull and western gull have all increased because these birds can effectively exploit artificial habitats, such as salt ponds and garbage dumps. California least terns, Caspian terns, California brown pelicans, herons and egrets have experienced major nesting failures in recent decades due to habitat loss and impairment by pollutants such as DDT, whose breakdown products cause thin eggshells. Least terns are making a comeback, but the future of this endangered species is still uncertain.

Raptors: Raptors have talons for grasping their prey, hooked beaks for tearing flesh and extraordinary eyesight. Each year, more than 10,000 hawks, kestrels, harriers, vultures and other raptors migrate over the Estuary region. Because they are high on the food chain, raptors are particularly susceptible to the biomagnification of contaminants such as DDT.

Trends: The endangered American peregrine falcon and the threatened bald eagle, along with

virtually all other raptor species, suffered major population declines in the last half-century, largely as a result of DDT use. Other causes include food contamination, habitat loss, urban expansion, wind-energy development and changes in agricultural practices. Recently, peregrines and bald eagles have been making a limited recovery nationwide.

Land Mammals: Many mammals live around the Estuary, including rodents, rabbits, bats, skunks, badgers, opossums, beavers, foxes, raccoons, bobcat and deer. Some rely on the Estuary watershed for habitat and fresh water; some fish for food in creeks, rivers and bays; and some hunt for bird eggs in wetlands.

Trends: Many small native mammals, including the endangered salt marsh harvest mouse, riparian (San Joaquin) woodrat, San Joaquin kit fox and riparian brush rabbit, are in decline due to habitat loss and fragmentation from urban and agricultural growth. They also suffer from competition and predation from opportunistic introduced species, such as the red fox, Norway rat and Virginia opossum, which are thriving as they readily adapt to urban environments.

Aquatic Mammals: Marine mammals, such as California sea lions, harbor seals, the threatened Guadalupe fur seal, and river otters inhabit or migrate through the Estuary. With the exception of river otters, these mammals are found primarily in those regions of the Bay that are more than 18 feet deep, although harbor seals must come on shore (haul out) to rest and give birth.

Trends: Harbor seal numbers in the Bay have remained fairly stable over the past decade. Sea lions are still recovering from past exploitation and increasing their ability to use such habitats as San Francisco's Fisherman's Wharf. River otters still frequent the Delta.

Amphibians and Reptiles: Numerous species of amphibians and reptiles once inhabited the Estuary's river channels, creeks, sloughs, lakes, ponds and seasonal wetlands. Amphibians may live on dry land, but can only breed in water, while reptiles are less dependent on aquatic environments. Most amphibian and reptile populations fell victim to widespread urban and agricultural development that destroyed their habitats. Today, only limited populations of these snakes, salamanders, frogs, turtles and lizards remain.

Trends: Species that have experienced dramatic depletion include the California tiger salamander, red-legged frog (federal threatened species), San Francisco garter snake and western pond turtle (California Species of Special Concern). Amphibians are experiencing declines worldwide, possibly because their permeable skin makes them more susceptible to toxic contamination.

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cides such as DDT and polychlorinated biphenyls such as PCBs. Primary sources of contaminants include urban and agricultural runoff, municipal industrial discharges, river inflows, dredging and dredged material disposal and spills. Contaminants can harm wildlife, fish and other aquatic organisms if they affect the food base or otherwise disrupt habitat required for survival.

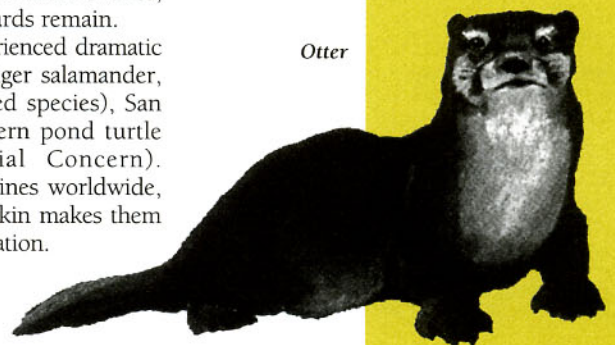
Natural River Flow and Freshwater

Diversion: Drought and water management practices reduce the flow of fresh water to the Estuary at certain times of the year and increase it at others.

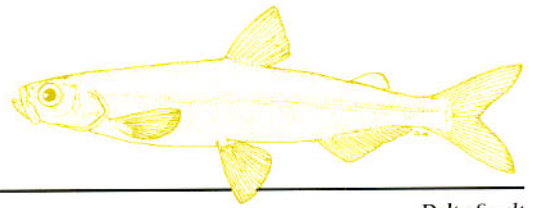
Impacts of reduced flows on fish include interruption of migratory patterns as a result of reverse river flows, entrainment of fish and important food sources in pump screens, loss of habitat and spawning areas, and reduced transport of species to downstream nursery areas. Impacts on birds and mammals include habitat loss and alteration.

Other Factors: Many other factors affect Estuary organisms and wildlife. Traffic across shoreline parks and refuges in the form of aircraft, human visitors and roaming pets disturbs wintering waterfowl. Power lines and wind energy generators block bird flight paths, resulting in collisions and electrocutions (500 birds a year in the Altamont Pass area). Dike building and maintenance disturb and destroy riparian habitats. Dredging and dredged materials disposal in the Estuary disturb and smother bottom-dwelling communities, and resuspend sediments and associated pollutants in the water column. Meanwhile, opportunistic introduced species continue to expand their populations and ranges, moving into degraded habitat areas, and often competing with, or preying on, native species.

Otter



Current Issues



Delta Smelt

Resources

San Francisco Estuary Project

Comprehensive Conservation and Management Plan (CCMP), 1993

Information Sheets: Agricultural Drainage, Aquatic Organisms & Wildlife, Dredging, Land Use, Pollutants, Research & Monitoring, Sacramento-San Joaquin Delta, San Francisco Bay-Delta Estuary, Under Siege: Aquatic Invasive Species, Water Usage, Wetlands

An Introduction to the San Francisco Estuary, 2000

State of the Estuary, 1990:
A Report on Conditions and Problems in the San Francisco Estuary

State of the Estuary 2000:
Restoration Primer

Status and Trends Reports, 1990-1992:
Aquatic Resources, Dredging, Land Use, Pollutants, Wetlands, Wildlife

California Department of Fish and Game
Booklets on waterfowl, fishes, furbearers and other wildlife

Contacts

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Marin Chapter (415) 383-1770
Santa Clara Chapter (408) 252-3747
www.audubon.org

CALFED Bay-Delta Program
1416 Ninth Street, Room 1155, Sacramento, California 95814, <http://calfed.ca.gov>, (916) 657-2666

California Department of Fish and Game
1416 Ninth Street, 12th Floor, Sacramento, California 95814, (916) 653-6420, www.dfg.ca.gov

California Waterfowl Association
4630 Northgate Boulevard, Suite 150, Sacramento, CA 95834, (916) 648-1406, www.calwaterfowl.org

Don Edwards San Francisco Bay National Wildlife Refuge
P.O. Box 524, Newark, CA 94560, (510) 792-0222, desfbay.fws.gov

Pacific Coast Federation of Fishermen's Associations
P.O. Box 29370, The Presidio, San Francisco, CA 94129-0196, (415) 561-5080, www.pcffa.org

Point Reyes Bird Observatory
4990 Shoreline Highway, Stinson Beach, CA 94970, (415) 868-1221, www.prbo.org

San Francisco Estuary Project
1515 Clay Street, Suite 1400, Oakland, CA 94612-1413, (510) 622-2465, www.abag.ca.gov/bayarea/sfep/sfep.html

U.S. Environmental Protection Agency
75 Hawthorne Street, San Francisco, CA 94105, (415) 947-8000, www.epa.gov/region09

U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605, Sacramento, CA 95825-1846, (916) 414-6600, www.fws.gov

Introduced versus Native Species

Over the years, many non-native species have been introduced into the Estuary region. Some, such as the American oyster, crayfish, striped bass and American shad, were deliberately introduced as food sources. Other non-native species continue to arrive unintentionally, often in ballast water. These species can become aggressive invaders when introduced into a new environment free of natural predators and competitors. The Asian clam *Potamocorbula*, the Chinese mitten crab, and European green crab are among the worst culprits. They prey on native species and have been particularly disruptive to the natural ecosystem.

Burgeoning *Potamocorbula* populations in Suisun Bay consume so much phytoplankton, they are affecting the aquatic food supply. Chinese mitten crabs damage commercial fishing nets and shrimp catches in San Francisco Bay. High densities of crab burrows destabilize riverbanks and levees. On the Estuary's shores, European starlings are aggressively competing for nesting holes, displacing titmice, nuthatches, and other birds; red foxes which escaped from Central Valley fur farms are destroying native vegetation and threatening the endangered California clapper rail. Efforts are being made to prevent new invasions of introduced species and to encourage native species recovery.

Habitat Loss and Degradation

Human influences on aquatic, shoreline and surrounding habitats will continue to have a major impact on organisms and wildlife in the future. Specific future impacts on habitats will include:

- Loss of 10,000 acres of wildlife habitat per year to accommodate projected population growth.
- Loss of 30 percent of the Bay Area's seasonal wetlands to development.
- Agricultural conversion to orchards and vineyards, which do not provide good habitat to Estuary species.
- Conversion of perhaps 50% of tidal flats in the South Bay to tidal marsh due to non-native invasive plants.
- Continued contamination from industrial and domestic wastewater discharges. Despite improved treatment, the total volume of wastewater will rise as population grows.
- Increased water diversion in the Delta due to growing urban and agricultural demand.
- Reduced wildlife use of wetland areas due to increasing human visitation and disturbance by domestic and feral animals.
- Degradation of wetland quality as developers mitigate the fill of natural wetlands by creating new wetlands that may be less ecologically productive and diverse.
- Conversion of salt ponds to other habitat as mitigation for wetlands fill. Although these ponds are man-made, they provide valuable habitat to shorebirds.

Habitat Restoration

Several recent public and private planning and habitat acquisition efforts, such as the Bay Area Wetlands Recovery Project launched in June 2000, may help offset some wetland losses in the future. Ongoing declines in habitat quantity and quality clearly demonstrate the critical shortage of funding, economic incentives and public resolve in support of habitat acquisition and

restoration. Public-private partnership efforts to protect habitat and create wildlife corridors between habitats remain essential to the future of wildlife in the region.

Endangered Species

Primarily as a result of habitat loss, at least seven insects, one reptile, three birds, one fish and five mammals have completely disappeared from the Estuary. Today, over 150 species of fish, insects, amphibians, reptiles, birds, mammals and plants in the Estuary are designated as endangered, threatened or of special concern by federal and state governments. This total represents about 15 percent of all the bird and mammal species occurring in the Estuary. Of these 90 taxa, 68 percent have been depleted through loss of wetland and riparian habitats.

An Ecosystem Approach to Research

Past research focused on a few species or on particular areas, with little coordination among studies. The declines of numerous species in the Estuary throughout the food web point to a general ecosystem-wide problem rather than a series of species-specific problems. If the Estuary is ever to be restored to a healthy system supporting major fisheries, we must take a unified, scientific approach to understanding the Bay-Delta ecosystem.

Estuary Project Goals

The San Francisco Estuary Project's primary goal is to restore and maintain water quality and natural resources in the Estuary while promoting effective management of Bay and Delta waters. The Project has developed specific aquatic resources and wildlife management goals in the Comprehensive Conservation and Management Plan.

Aquatic Resources Management Program Goals:

- Stem and reverse the decline in the health and abundance of estuarine biota (indigenous and desirable non-indigenous), with an emphasis on natural production.
- Restore healthy estuarine habitat conditions to the Bay-Delta, taking into consideration all beneficial uses of Bay-Delta resources.
- Ensure the survival and recovery of listed and candidate threatened and endangered species, as well as other species in decline.
- Optimally manage the fish and wildlife resources of the Estuary to achieve the purpose of the goals stated above.

Wildlife Program Goals:

- Stem and reverse the decline of estuarine plants and animals and the habitats on which they depend.
- Ensure the survival and recovery of listed and candidate threatened and endangered species, as well as special status species.
- Optimally manage and monitor the wildlife resources of the Estuary.